The Fitness Professional's Guide to Training Clients with Osteoarthritis

Accompaniment to the online course developed by the American Council on Exercise *in partnership with the* Association of Rheumatology Health Professionals and the Arthritis Foundation

INTRODUCTION

Inflammation, injury, and pain of the joints, muscles, connective tissue, and/or soft tissues surrounding the bones and joints characterize over 100 rheumatologic disorders. Table 1 below shows a brief overview of the most common of these disorders.

Table 1. Most Common Rheumatologic Disorders with Joint Involvement

Diagnosis	Disease Type	Commonly Affected Joints	Disease characteristics
Osteoarthritis	Local degeneration	Hands, spine, knees, hips	Joint pain, stiffness with use of joints Osteophytes, Cartilage degeneration
Rheumatoid arthritis	Inflammatory, systemic	Wrists, hands, knees, feet, cervical spine	Morning stiffness >30 minutes Acute and chronic inflammation Chronic pain and loss of joint integrity
Ankylosing spondylitis	Inflammatory, systemic	Hands, knees, elbows, feet, spine	Arthralgia (pain in joints) Fatigue Acute iritis (eye inflammation) Inflammation and pain of the sacroiliac joints Inflammation at the site of the tendinous insertion into bone (enthesitis)
Psoriatic arthritis	Inflammatory, Systemic with skin involvement	Hands, wrists, knees, feet and spine	Joint pain, morning stiffness and loss of joint integrity, nail dystrophy, swelling of entire finger/toe (dactylitis or sausage digit), joints can become involved before skin and vice versa
Systemic Lupus Erythematosus	Inflammatory, systemic	Hands, feet, knees and hips	Joint pain, morning stiffness Fatigue, hair loss, oral ulcers, sun sensitive rashes, renal disease
Gout Pseudogout	Crystal deposition in joints	Great toe, ankles, knees, wrists	Acute joint inflammation Pain Tophi (monosodium urate crystals deposit beneath the skin)

Adapted, by permission, from M.A. Minor and D.R. Kay, 2009, Arthritis. In *ACSM's exercise management for persons with chronic disease and disabilities, 3rd edition*, edited by J.L. Durstine, G.E. Moore, P.L. Painter, and S.O. Roberts (Champaign, IL: Human Kinetics), 260. Additions by Patience H. White, MD, MA.

Rheumatologic disorders tend to be chronic and incurable; however, most can be effectively managed with proper treatment programs. Osteoarthritis (OA) is the most common joint disorder in the United States, affecting an estimated 27 million Americans (Lawrence et al, 2008). Cartilage degeneration is the hallmark of OA. The cartilage ulceration that begins superficially can extend into deeper layers, affecting the subcondral bone. Eventually, bone spurs (i.e., osteophytes) may develop in the affected joint and focal inflammation may be observed (Ling & Rudolph, 2006). The most commonly affected joints include weight-bearing joints, such as the knee, hip, and spine, as well as the small joints of the hand.

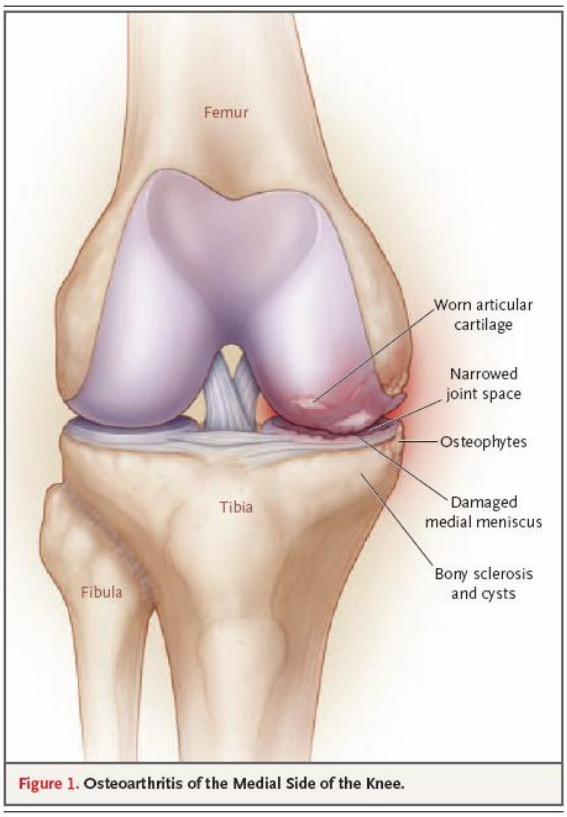
Characterized by joint pain, morning stiffness, joint instability (late stage) and buckling (knee joint), and sometimes loss of function of the affected joint, OA can be debilitating. As a fitness professional knowledgeable about OA, the disease process, and the most effective exercise interventions, you will be uniquely positioned to meet the needs of millions of people with early and mild OA who aim to safely lead a rewarding and low-pain physically active lifestyle. This continuing education course, which includes the online interactive course and PDF of the Strength Exercise Progressions list, will arm you with the tools you need to get started and design a safe, effective, and motivating exercise program for your clients who suffer from OA.

OSTEOARTHRITIS OVERVIEW

The pathogenesis of primary, or idiopathic, OA is poorly understood. Old age, female gender, previous injury to a joint, high bone mass, genetic predisposition, increased body mass index (BMI), participation in weight-bearing sports (e.g. elite running), and occupations that require prolonged standing, lifting, moving of heavy objects, or handling vibration tools (as in construction) all increase risk (Lane, 2007) while moderate physical activity decreases risk (Manninen et al, 2001). Other diseases such as hemochromatosis, hyperparathyroidism, hypothyroidism, acromegaly, hyperlaxity syndromes, Paget's disease, gout, and chondrocalcinosis can also lead to what is known as secondary OA (Lane, 2007).

While the initial events that lead to OA are not well-delineated, OA likely begins with degradation of articular cartilage, a tough material that cushions and protects the bone ends. The degradation may be stimulated by high circulating levels of proinflammatory cytokines and other inflammatory cells. The result is that the cartilage that once allowed bones to smoothly glide over one another and that effectively absorbed the shock of physical movement becomes damaged and ineffective. This can cause pain, swelling and diminished range of motion. Bones may eventually rub against one another during movement. Sometimes small deposits of bone known as osteophytes begin to grow at the edge of the joint, causing more pain and damage when they break off and float into the joint space. OA of the medial knee is depicted in Figure 1 below.

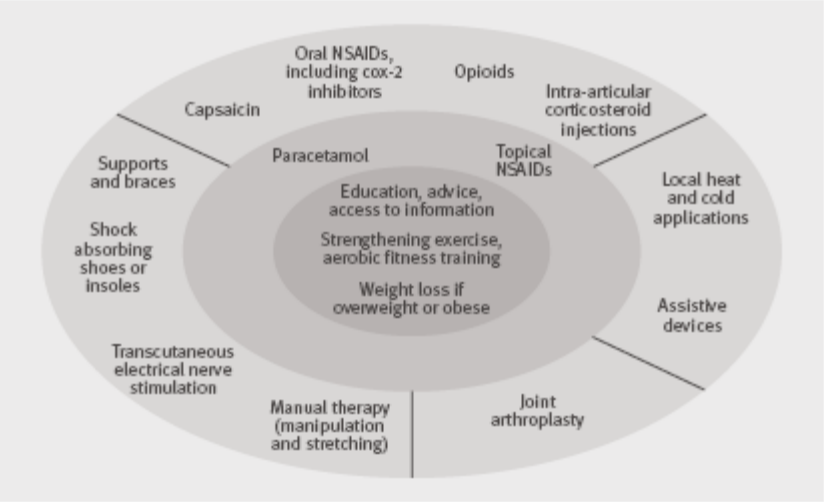
Figure 1. Osteoarthritis of the Medial Knee



Reference: Felson, D.T. (2006). Osteoarthritis of the knee. *New England Journal of Medicine*, 354, 8, 841-848.

The best practice treatment recommendations for people with OA are based on expert opinion and a limited number of imperfect research studies of short duration and small sample size. Core treatments include education to increase understanding of the disease and dispel myths – such as the pervasive belief that exercise further damages osteoarthritic joints; exercise including muscle strengthening, aerobic fitness, and flexibility training to maintain mobility; and weight loss to limit joint stress. Adjunct interventions include non-pharmacological, pharmacological, and surgical treatments (Conaghan et al, 2008) (see Figure 2 below).

Figure 2. Osteoarthritis Treatments



Treatments for osteoarthritis in adults. Starting at the centre and working outwards, the treatments are arranged in the order in which they should be considered, taking into account individuals' different needs, risk factors, and preferences. The core treatments (centre) should be considered first for every person with osteoarthritis. If further treatment is required, consider the drugs in the second circle before the drugs in the outer circle. The outer circle also shows adjunctive treatments (both non-pharmacological and surgical), which have less well proved efficacy, provide less symptom relief, or increased risk to the patient compared with those in the second circle

Reference: Conaghan, P.G., Dickson, J., Grant, R.L., et al (2008). Care and management of osteoarthritis in adults: summary of NICE guidance. *British Medical Journal*, 336, 502-503.

EXERCISE AND OSTEOARTHRITIS

Exercise is an important component in the management of OA. In fact, expert panels have convened to develop consensus guidelines on the role of exercise in the treatment of OA based on the latest research and expert opinion. These include the MOVE guidelines (Roddy, et al, 2005), and the OARSI recommendations (Zhang et al, 2008). The main conclusions of the MOVE consensus, all of which emphasize the important role of exercise in treating OA, are summarized below in Figure 3.

Figure 3. The MOVE Consensus: Recommendations for the Role of Exercise in the Management of Osteoarthritis of the Hip or Knee

1. Both strengthening and aerobic exercise can reduce pain and improve function and health status in patients with knee OA*, and presumably hip OA.
2. There are few contraindications to the prescription of strengthening or aerobic exercise in patients with hip or knee OA.
3. Prescription of both general (aerobic fitness training) and local (strengthening) exercises is an essential, core aspect of management for every patient with hip or knee OA.
4. Exercise therapy for OA of the hip or knee should be individualized and patient-centered taking into account factors such as age, co-morbidity, and overall mobility.
5. To be effective exercise programs should include advice and education to promote a positive lifestyle change with an increase in physical activity.*
6. Group exercise and home exercise are equally effective and patient preference should be considered.*
7. Adherence is an important predictor of long-term outcome from exercise in patients with knee or hip OA.*
8. Strategies to improve and maintain adherence should be adopted, e.g. long-term monitoring/review and inclusion of spouse/family in exercise.*
9. Improvements in muscle strength and proprioception gained from exercise programs may reduce the progression of knee and hip OA.

Note: statements with * are supported by research; those without are based primarily on expert opinion.

Reference: Roddy E., Zhang W., Doherty M., et al (2005). Evidence-based recommendations for the role of exercise in the management of osteoarthritis of the hip or knee – the MOVE consensus. *Rheumatology*, 44, 1, 67-73.

Despite the recognized importance of exercise in treating OA, many individuals with OA avoid physical activity due to severe joint pain and fear that the exercise will further damage the affected joints. In fact, inactivity can lead to further deconditioning and loss of strength, flexibility, and endurance – all components of fitness necessary to overcome the pain and physical limitations associated with the disease. As the severity of OA worsens and mobility decreases, physical function and the ability to engage in activities of daily living (such as walking, climbing stairs, getting in and out of a chair, lifting, and carrying) become increasingly difficult. Education to dispel common myths and misunderstandings regarding exercise and OA is critical.

COMMON MISUNDERSTANDINGS

Myth: *"There is nothing one can do with OA."*

Although there is no cure for OA, proper exercise, physical activities, and weight management strategies have been shown as effective treatments to slow down the progression of joint damage and reduce the need for joint replacement surgery. People with most forms of arthritis can benefit greatly from regular exercise. Walking, low impact aerobic exercise, stationary cycling and aquatic exercise have all been shown to be safe and effective in reducing pain and improving joint mobility, muscle strength, aerobic capacity and

endurance.(Ottawa Panel, 2005) More recently, alternative exercises, such as yoga and Tai Chi, have been shown to be helpful and safe in people with arthritis (Fransen et al., 2003). Strong muscles help to stabilize affected joints and reduce the impact forces through these and adjacent joints.(Radin & Paul, 1971) Therefore, a well-designed exercise program may help to slow the progression of the joint damage. Finally, many people with OA are overweight which can be both a risk factor for developing the disease as well as a factor in disease progression (Bliddal & Christensen, 2006; Christensen et al., 2007). Regular exercise can help individuals to maintain a healthy body weight and reduce the impact and other joint stresses on the weight bearing joints.

Myth: *"Exercise makes my joint pain worse."*
Many people with OA do not exercise for fear of pain, joint injury and worsening the condition. This can lead to the cycle of reduced activity leading to joint stiffness and muscle weakness, altered biomechanics and increased pain. Together these contribute to decreased function and ability to perform daily activities, poor sleep patterns and fatigue, reduced coping skills and stress. Regular exercise and physical activity can help to break this cycle and contribute to less pain and a more active lifestyle.

Myth: *"I am too old to start exercising."*
Many older individuals have not formally exercised in many years and may feel embarrassed or anxious about starting an exercise program especially if there are much younger participants in the group. Fitness professionals who work in a group setting may encourage everyone to start slowly and monitor their body's response to exercise. It is useful to explain that some post-exercise discomfort is common when first starting a program, that delayed onset muscle soreness can occur in the untrained muscles, and that this temporary and usually mild discomfort differs from joint pain and flare ups made worse by exercise.

BENEFITS AND RISKS OF EXERCISE

Exercise serves many important functions for individuals with OA including: improved physical function (Fransen et al, 2003); decreased joint swelling and pain (Fransen et al, 2003); maintenance of cardiovascular status, muscular fitness, and overall health; weight loss; and decreased depression and anxiety (Minor, 2002). Exercise is rarely absolutely contraindicated in individuals with OA. People with the following unstable symptoms or conditions should carefully weigh the risks and benefits of exercise with a treating physician. (Roddy et al, 2004).

- an acute febrile illness
- a viral infection
- history of pre-existing cardiovascular disease including hypertrophic obstructive cardiomyopathy, significant aortic stenosis, acute myocarditis, and exercise-induced ventricular arrhythmia.

At the same time, exercise is inherently risky, especially if a client overtrains. Signs of overtraining include:

- joint pain/discomfort *during* the exercise session or pain that lasts more than two hours after exercise and/or exceeds pain severity before exercise
- increased joint swelling/tightness immediately after or the day following activity
- decreased range of motion
- increased weakness
- altered gait following participation in a weight-bearing activity
- unusual or persistent fatigue.

A well-designed exercise program must be tailored to the individual's current abilities and limitations to optimize safety and minimize the risk of the making the condition worse. For example, clients should be taught to avoid overexertion and extreme joint flexion, balance rest and activity, control weight and eat sensibly, and respect pain (Stitik et al,2007). Individuals who have undergone joint surgery for their OA should carefully follow the exercise instructions and precautions provided by their surgeon and/or physical therapist. A quality program also will center on the client's enjoyment and satisfaction as long-term exercise adherence is alarmingly low (Hendry et al, 2006), and if exercise is not maintained, its benefits eventually disappear (Pisters et al, 2007).

RECOMMENDATIONS FOR HEALTH SCREENING

The Initial Interview

The initial interview with a client offers an opportunity to assess the client's commitment to exercise, past health concerns and limitations, relationship with a physician and/or physical therapist, current understanding of OA, and exercise interests. Several factors such as increased education, history of exercise participation, a positive attitude towards exercise, self-efficacy, social support, and perceived benefits increase the likelihood that a client will adopt a regular exercise program while perceived frailty and poor health are barriers (Rhodes et al, 1999). Using this information, the fitness professional can design an exercise program that highlights the client's strengths and deemphasizes weaknesses and perceived limitations.

Prior to starting an exercise program, all clients should be screened for health risks that prevent them from starting exercise. One example of a screening tool is the Pre Activity Readiness Questionnaire (PAR-Q).(Thomas et al., 1992) The PAR-Q consists of seven questions. Individuals who answer 'yes' to one or more questions should consult their family physicians prior to starting a fitness program.

In addition, fitness professionals should ask their clients three critical questions to ascertain readiness to participate in an exercise program

1. **Do you have any medical condition that could affect your participation in an exercise program?**

It is important to confirm that the client has OA and not inflammatory arthritis, such as rheumatoid arthritis (RA). If the individual complains of pain and/or swelling in three or more joints, involvement of the small joints of hands or feet; and prolonged morning stiffness greater than 30 minutes (Emery et al., 2002), he/she should consult with the family physician before starting an exercise program.

Participants also need to know which joints are affected so that the fitness professional can modify or adapt the exercise regime appropriately. If the individual has had joint replacement surgery, the fitness professional should find out the date of the surgery and the precautions that he/she has been advised to follow. If the surgery was within the past 3 months, it is recommended that he/she should see a physical therapist with experience in post-surgery rehabilitation before starting an exercise program.

Finally, individuals should not exercise if they experience significant fatigue or general malaise, or have recently (within 48 hours) received a corticosteroid injection to the joint that will be involved in the exercise.

2. **Are you currently taking any medications?**

Some people with mild or early OA do not need to take medications. However, some may require painkillers such as Tylenol, ASA (Aspirin) or Ibuprofen. Some arthritis medications such as ASA and other non-steroidal anti-inflammatory drugs (NSAIDs) affect blood clotting, which can lead to easy bruising with minimal injury or pressure. In addition, people may experience dizziness with prolonged use of NSAIDs. It is also important to know the timing of the client's medications and whether he/she experiences side effects. This will affect the timing and frequency of the client's exercise routine.

3. **Have you been doing exercise?**

Specific questions may include the type, intensity, frequency and duration of exercise. If the client has already exercised regularly, find out if those are therapeutic exercises prescribed by a physical or occupational therapist, or recreational exercise, such as walking, golfing, or swimming. Clients should be asked if the exercise increased joint pain, stiffness, fatigue or shortness of breath during or after the session. This information can be used to determine the individual's readiness to exercise, activity tolerance, and whether specific intervention is required to enhance adherence to the exercise routine.

<u>When to refer</u>

If the client has prolonged joint pain or if the fitness professional suspects that the client may have OA and has never been diagnosed, he/she should be referred to see a family physician. The family physician may prescribe pain

medications and NSAIDs that help to lessen the joint discomfort or refer the individual to a rheumatologist, a physician with specialized training in osteoarthritis and other rheumatological diseases. Also, if the client experiences any significant changes in their joint symptoms (e.g., a substantial and prolonged increase in joint pain and/or swelling) and/or general health status, he/she should be asked to consult the family physician before starting or resuming exercise.

While many people with OA may continue exercise and physical activities, research in knee OA suggests that individuals with joint instability and malalignment should be prescribed tailored therapeutic exercise to avoid further joint damage. For this reason, people with knee OA who had previous injuries to the ligaments (e.g., anterior cruciate ligament) and/or malalignment (valgus, varus) should be assessed by a physical therapist prior to starting an exercise program. Also, when in doubt if an exercise or a piece of equipment is appropriate for the client, it is recommended that the fitness professional contact a physical therapist with experience in arthritis care.

Addressing Comorbidities

Clients with OA may have a variety of other health challenges in addition to arthritis. Many of these conditions may be unrelated to OA and occur simply due to increased age whereas others, such as obesity, may have predisposed the client to develop OA. As with all clients, it is important to carefully complete a health history form, risk stratify based on ACSM guidelines (American College of Sports Medicine, 2005), and seek physician clearance and evaluation to thoroughly assess the severity and extent of joint involvement, presence of systemic involvement, overall functional capacity, and presence of other medical conditions that may interfere with exercise. It is advisable that, with the client's permission, the fitness trainer work closely with the client's physician and physical therapist to design the safest, most effective, and most enjoyable exercise program possible.

Obesity is probably the single most important risk factor for the development of severe OA of the knee, even more so than heredity (Bliddal & Christensen 2006). An understanding of the relationship between obesity and OA is important to help guide exercise recommendations. For example, obesity increases the loading on the knee. The increased load combined with varus malalignment (bowed legs), present in about half of clients, may cause the cartilage degeneration in obese clients (Bliddal & Christensen, 2006). Further, quadriceps weakness in obese clients with OA may further stress the cartilage with ambulation. Obesity also may predispose an individual to OA through inflammatory pathways that are not yet fully understood (Bliddal & Christensen, 2006). Obesity not only contributes to the development of OA but it also affects the prognosis, especially when an individual's obesity leads to a cycle of decreased exercise, diminished muscle strength, and increased joint troubles. A weight-loss program combined with physical activity is the recommended strategy for management of OA in obese individuals. Some recommend that weight-loss occur prior to exercise to minimize undue joint

stress and maximize exercise enjoyability (Bliddal & Christensen, 2006), but research suggests that weight-loss alone is not enough to reduce pain and improve function (Messier et al, 2004).

Exercise Testing

Though clients may suffer from joint pain and some exercise limitations, exercise testing can be safely implemented. ACSM recommends the following exercise testing program for individuals with OA (shown in Table 2):

- *Muscular strength and endurance*. Use isokinetic machines at 90-120E/second to measure the strength and endurance of major muscle groups
- *Aerobic endurance*. The six-minute walk test is a safe and effective assessment of endurance in this clientele.
- *Joint flexibility and range of motion*. Use a goniometer to measure joint range of motion. Also assess asymmetry.
- *Neuromuscular fitness*. Gait analysis may be necessary for clients who have severe disease, altered biomechanics, or a need for orthotics. Also assess balance.

Table 2. Exercise Testing for Clients with Arthritis

Methods	Measures	Comments
Strength Repetition maximum (1, 8 or 12) Isometric knee extension Standardized functional measures	•Timed chair rise •Timed up and go	Method depends on specific joint involvement and pain
Endurance 6-min walk Aerobic capacity test	•HR •RPE (6-20)	Method depends on specific joint involvement and pain
Flexibility Goniometry	•Functional range of motion •Assess symmetry	Helpful in preventing contractures and injury
Functional Balance Gait	•Berg Balance Test •Short Physical Performance Battery •Walk: observe for asymmetry	

Adapted, by permission, from M.A. Minor and D.R. Kay, 2009, Arthritis. In *ACSM's exercise management for persons with chronic disease and disabilities*, 3rd *edition*, edited by J.L. Durstine, G.E. Moore, P.L. Painter, and S.O. Roberts (Champaign, IL: Human Kinetics), 263.

Functional capacity

Assess capacity to accomplish activities of daily living by observing ability to walk with balance and symmetry, ability to sit and then stand up several times, and ability to stand in one place without difficulty. The arthritis impact measurement scale/health assessment questionnaire, a somewhat long and comprehensive questionnaire utilized by clinicians and researchers, can also

provide valuable information on functional ability. WOMAC is the most commonly used standardized measure for assessing pain, stiffness and function in people with OA in the lower limb joints. AUSCAN is a similar measure for the hand joints.

PROGRAM DESIGN AND IMPLEMENTATION

General Considerations

From activities of daily living (ADLs) and recreational sports to therapeutic exercises and a scheduled flexibility, resistance and cardiovascular exercise program, individuals with OA can benefit from myriad types and formats of physical activity. Regardless of the form of exercise, some general exercise guidelines can help minimize the pain that clients with OA experience, and thus help to maximize adherence. To start, it is important to recognize that many types of arthritis have unpredictable "up and down" courses with fluctuation between remissions and flare-ups. While exercises may be done easily in one session, the next session they may prove too difficult, and the trainer should be prepared to make modifications as needed. Some potential exercise modifications include:

- Decreasing the resistance
- Decreasing the exercise frequency
- Changing the equipment used
- Altering the body position to avoid pain –stand, sit, prone, supine, side-lying (a non-weight bearing position may be better tolerated).
- Limiting the joint range of motion
- Reducing the number of repetitions or exercise duration (aerobic exercise).
- Reducing the number of weekly training sessions in which a client performs the same exercise (expand cross training) or insert break days.

Further, any exercise that causes the client to experience worsening pain should be avoided. While muscle soreness and discomfort is a normal response to exercise, any joint pain that lasts for two or more hours after exercising is an indication to reduce intensity the following session. Progressive training beginning with minimal overload is most effective and exercises in a pool or partial-weight-bearing exercises often are better tolerated than full weight-bearing exercises (Felson, 2006).

Exercise is best accomplished at times of the day when joints are the least stiff, energy is the highest, and any medication the clients takes is at its maximal effectiveness. It is also acceptable for clients to divide an exercise program into short bouts throughout the day rather than an extended training session at one time. Additional recommendations for clients with OA are shown in Figure 4 below.

Figure 4. Arthritis Exercise Principles

- Move joints daily
- Move an inflamed joint gently through its range of motion
- Begin all exercise with a warm-up of slow exercises to minimize joint stress
- Take a *warm* shower just prior to exercise to help make exercise more comfortable, as heat relaxes joints and muscles and helps to relieve pain.
- Perform exercises with a slow, steady rhythm without bouncing. Allow muscles time to relax between repetitions.
- Attempt to achieve full range of motion to the point of a mild discomfort but not pain. While these exercises may not improve range of motion, they can help prevent further restriction.
- Breathe in a normal, deep, rhythmic pattern and avoid breath holding.
- Choose exercises that minimize stress on the joints. High-resistance exercises should be done only under the supervision of a physical therapist
- Listen to your body and move at your own pace. If an exercise hurts, stop. If you feel tired, rest. Discontinue exercise if you experience chest pain, shortness of breath, dizziness, or nausea.
- Encourage the support of family and friends to optimize adherence.

Adapted from Arthritis Foundation (2009). Arthritis Foundation Exercise Program Instructor's Manual.

Also note that the "tell-show-do" approach to teaching new exercises in which the trainer first describes and then demonstrates the exercise before the client executes the exercise is particularly effective in minimizing risks of injury from improper exercise execution.

Using Joints and Energy Wisely

The major impact of joint disease on exercise programming is the need for joint protection as joints affected by OA are vulnerable to stress and can be damaged more easily than unaffected joints. All fitness professionals working with clients with OA should consider the ACSM recommendations (Minor & Kay, 2002) for joint protection when developing an exercise program for the affected client (shown in Table 3 below):

Table 3. ACSM Recommendations for Exercise Programming for Clients with OA

Mode	Goal	Intensity/Frequency/Duration	Joint Protection Strategies
Aerobic Large muscle activities (walking, cycling, rowing, swimming, water aerobics, dance)	Increase VO_2 max, peak work, work rate and endurance	• 60-80% peak HR or 40-60% VO_2 max • RPE 11-16/20 • 3-5 days/week • 5-10 min/session building to 30 min/session • Emphasize progression of duration over intensity	• choose low-impact activities • avoid vigorous, highly repetitive exercise on unstable joints • avoid stair-climbing, contact sports, and activities requiring prolonged one-legged stance, or rapid stop-and-go
Resistance • Circuit training • Free weights • Weight machines • Elastic bands• Isometric exercises	Increase 1-, 8-, 12- repetition maximum Increase repetitions and resistance Increase peak torque or power	• 1 or more sets of 2-3 reps initially, building to 10 reps • 2-3 days/week training	• Condition muscles prior to increasing exercise intensity • If pain or swelling appears or persists, reduce load on joint
Flexibility Stretching	• Increase/maintain pain-free range of motion • Decrease stiffness	Before aerobic or strength activities	• Avoid overstretching and hypermobility • Move slowly and gently through ROM and NOT past point of discomfort • Warm environment promotes elasticity
Functional Addresses functional needs; stimulates daily activity	• Improve balance • Improves ADLs • Improve gait		

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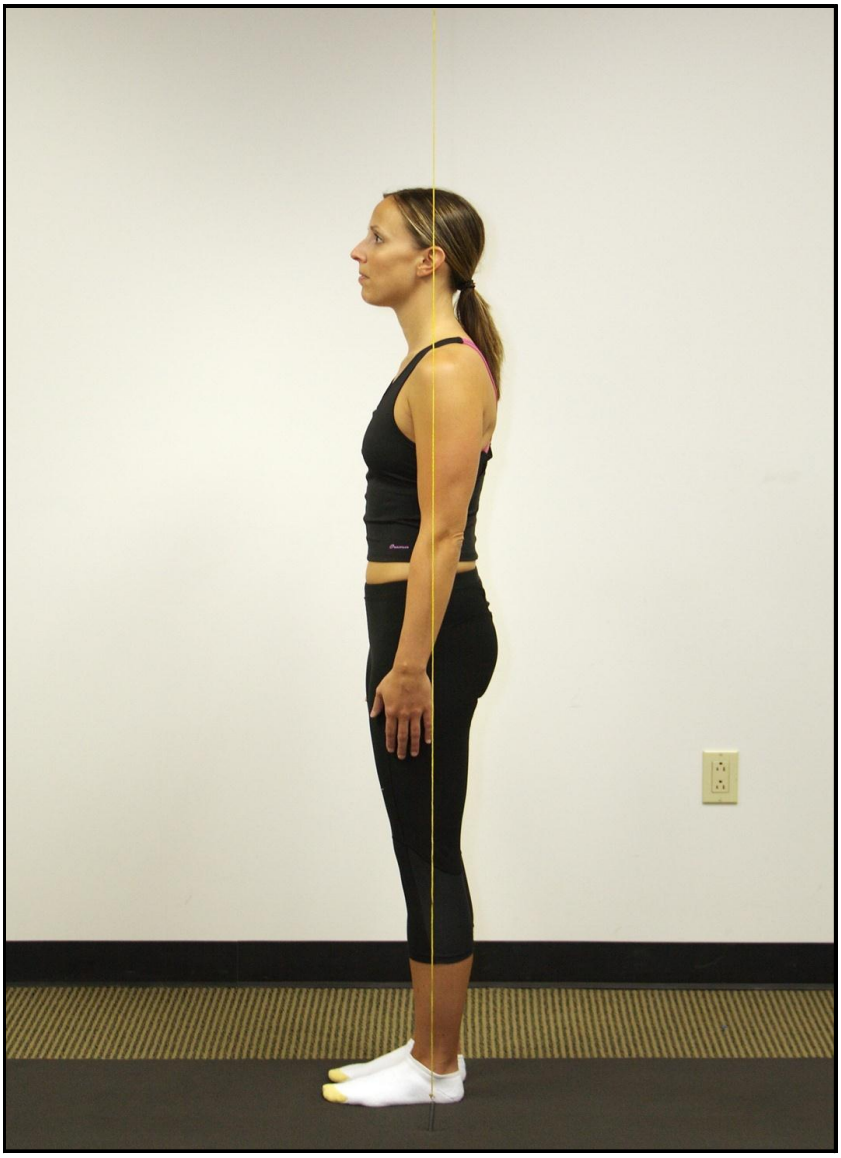
Maintaining Appropriate Posture

Clients can benefit from extra guidance on maintaining appropriate posture which can reduce strain on muscles and joints. When standing with good posture, the middle of the shoulders, knee, and back of the ankle are in alignment (see Figure 5 below). Useful instructional cues to help clients achieve good posture include: "chest up, chin in, shoulders back, stomach tucked, buttocks tight, and knees soft."

Figure 5. Correct Postural Alignment



Training Considerations

When preparing to design an exercise program for a client with OA, keep in mind the following general programming considerations recommended by ACSM (Minor & Kay, 2002):

- Use low intensity and duration during the initial phase of programming
- If necessary, accumulate exercise dose during several sessions throughout the day
- Recommend alternate exercise modes and interval or cross-training methods to allow for changes in disease status

- Set time goals, rather than distance goals, to encourage self-management to pace activity
- Choose an appropriate exercise/fitness goal, and recommend that the person not exceed intensity, duration, and frequency guidelines for training

The wrong kinds of exercise can also exacerbate OA problems. For clients with OA primarily behind the patella, stationary cycling can be very painful as can repeated stepping or squatting. The traditional seated knee extension (open kinetic chain) strengthening exercise places greater shearing stress on the knee joint and ACL ligament. Spinal OA reduces the discs' ability to absorb shock and withstand shearing and rotary stresses. Any higher impact activity or upper limb strengthening that loads the spine from above can exacerbate spinal pain.

While general exercise guidelines apply to individuals with hip and knee OA, the following joint-specific recommendations also are important to incorporate into an exercise program.

Knee Osteoarthritis. Quadriceps weakness results from disuse and inhibition of muscle contraction in the presence of capsular swelling. The severity of pain is directly correlated to the degree of muscle weakness (Felson, 2006). Therefore, quadriceps strengthening is a vital exercise component to reduce pain and also improve joint stability for clients with OA of the knee, though it is important to note that strong muscles may promote structural deterioration in malaligned knees. Clients with malalignment, ligament laxity and previous joint injury should consult a physical therapist BEFORE starting exercise, since generalized or quadriceps strengthening may not address the problem. The exercises most likely to be effective are those that imitate activities of daily living. Thus, while range-of-motion and isometric exercises are included in ACSM recommendations, research suggests that isotonic and isokinetic strengthening in addition to low-impact aerobic exercise are most effective in reducing pain and improving function (Felson, 2006). Any exercise that causes a client to experience worsening pain should be immediately discontinued.

Hip Osteoarthritis. Exercise interventions for treatment of OA of the hip have been less well studied than treatment for the knee. One randomized controlled trial found that 70% of studied individuals with either knee or hip OA who were assigned to an aquatic exercise program for six weeks experienced improvements in pain and function versus only 17% of individuals who received no intervention (Hinman et al, 2007). A 2007 review of the literature to date concluded that aquatic exercise has some beneficial short-term effects for patients with hip and/or knee OA but insufficient data exists on long-term outcomes (Bartels et al, 2007).

ACSM Program Design Recommendations

A well-designed program for a client with OA includes exercise recommendations for flexibility, resistance and cardiovascular training as well as balance and functional training with a special emphasis on joint protection (see Table 3).

Flexibility Training. Joints that are inflamed or damaged by arthritis often have limitations in ROM. As tendons, muscles, and ligaments shorten, people with OA may experience increased pain as they move, especially at the extremes of joint movement. With losses in motion, functional activities become more difficult to perform. Joints that are not involved with arthritis also may lose normal motion as the individual's overall activity level decreases (Arthritis Foundation, 2005). Active range-of-motion exercises have been shown to decrease discomfort and pain, which can increase function and overall independence (Bashaw & Teingstad, 2005). Range-of-motion exercises involve repetitive, smooth and dynamic movement through a joint's full range of motion. Static stretching involves stretching a muscle to a point of muscle tension (not pain) and holding that position for 20-30 seconds. Static stretching exercises may promote increased muscle length and also improve ease of movement. Some samples of stretching hip-girdle and knee region muscles are described in the "Strength Exercise Progressions" list that accompanies this course. Clients also may enjoy and benefit from classes or instruction in yoga, pilates, gyrotonics, Tai Chi, or Qui Gong. Should a client choose one of these formats, it is especially important for them to be certain that they find a quality instructor who is familiar with modifications for individuals with OA.

Resistance Training. Individuals with OA frequently lack normal muscle strength, especially in the muscles surrounding the involved joint. They also may have generalized muscle weakness from decreased activity levels or from the side effects of some medications. Research suggests that strengthening the muscle groups around the affected joints leads to improved strength, function, and pain in individuals with OA (Roddy et al, 2005). A strengthening program should be tailored to a client's ability. Among individuals with knee OA, both quadriceps and hip strengthening are critical. Quadriceps strengthening exercises can progress from low-level exercises such as "quad sets" and "straight leg raises" to moderate-level wall slides, then to leg press. Wall slide and leg press exercises are examples of closed-chain kinetic exercises, in which the distal limb (foot) is in direct contact with the floor or leg press machine. This contact helps dissipate forces acting on the knee. In open-chain kinetic exercises the distal limb is *not* in direct contact with a surface (e.g. leg extension). Research suggests that open-chain kinetic exercises increase forces within the knee and should be avoided in clients with OA, other than straight leg raises which help to build initial strength in beginners. (These exercise descriptions and photos can be found in the "Strength Exercise Progressions" list that accompanies this course.) (Stitik et al, 2007)

Cardiovascular Exercise. In addition to its overall health benefits, cardiovascular exercise also reduces morning stiffness, improves balance, increases walking speed, and reduces pain and symptoms of depression and anxiety in individuals with OA (Stitik et al, 2007). Despite these benefits, over 60% of individuals with arthritis do not meet recommendations for physical activity (Fontaine et al, 2004). The best exercises to improve cardiovascular endurance in clients with OA are compatible with the client's cardiovascular level, joint involvement, preference, and accessibility of equipment. While aquatic exercise programs may work best for some, cross-training including a mix of land- (such as stationary cycling, chair exercises, rowing, walking, and dancing) and water-based exercises with varying degrees of weight-bearing is best for others.

Balance Training. Coordination and balance are necessary for smooth, integrated, efficient movement. Balance requires both static and dynamic equilibrium. Pain and decreased joint mobility and muscle strength disrupt the performance of efficient, controlled, and integrated movements. Stiff, painful, and awkward movement requires more energy and increases fatigue. Decreased lower extremity strength and over-stretched ligaments and tendons lead to joint instability, resulting in poor balance and coordination. Teach balance training by introducing progressive balance challenges. For example, progress from double limb to single limb stance activities. Activities on unsteady surfaces such as rocker boards, balance discs, BOSU balls, and foam cushions are fun and effective ways to improve balance. However, it is important to ensure that your client has adequate strength to support the knee and hip joints and maintain good alignment *before* introducing unstable surfaces.

Functional Training. Functional training aims to emulate ADLs and make performing every day activities safer and easier. Emphasis on ADLs is important as people with OA experience pain and stiffness and may be unable to perform certain ADLs – or may do them in ways that further stress their joints. Some examples include practicing – with impeccable form -- getting in and out of a chair and picking an item off the floor.

ADJUNCTS TO REHABILITATION AND EXERCISE IN THE MANAGEMENT OF OSTEOARTHRITIS

Athletic shoes

For people with OA of the hips, knees, feet or back, supportive shoes are important to minimize discomfort while performing exercise. OA often affects the big toe joint (metatarsal phalangeal joint) and the rear foot. This tends to restrict motion at the involved joint, causing pain during exercise and physical activities. Proper footwear is, therefore, important to accommodate the joint problem and facilitate a smooth and pain-free gait. When getting a pair of

athletic shoes, clients should consider the following features:(Hillstrom et al., 2006)

- The key to foot comfort is to prevent the development of stress or irritation. Individuals with a wide or splayed foot, or those who are developing bunions or hammer toe, may require shoes with wider and extra-depth *toe box* (i.e., the front of the shoes that cover the toes) to accommodate the condition. The toe box should also be flexible to allow for toe movement.
- Athletic shoes should support areas of instability and protect areas of deformity. A firm *counter* (i.e., the back of the shoe) helps to keep the ankle vertical and resists the tendency to roll inward with weight bearing. A padded *collar* (i.e., an extension along the top of the counter to the laces) can protect the ankle from irritation.
- *Shoelaces* provide support to the mid-foot and should be snugly fastened. Laces can be adjusted to allow for swelling. Velcro closure or elastic shoelaces are acceptable alternatives if the client has hand involvement that prevents lacing.
- The *sole* of the shoe should be reinforced in the back by a stiff piece of plastic, known as the shank. This provides support for the longitudinal arch of the foot by keeping the shoe from bending in the middle.
- The shoes should be roomy enough to accommodate for orthotics. Instructors might remind their clients to bring their orthotics when they shop for athletic shoes.

<u>Thermotherapy before or after exercise session</u>

Thermotherapy involves applying heat or cold to joints to improve the arthritis symptoms. Heat may work by improving circulation, relaxing muscles, and decreasing joint stiffness, Research on the use of heat before and after exercise for people with OA is inconclusive.(Brosseau et al., 2008) However, because temperature sensitivity is common in people with joint pain, sometimes a warm shower or heat pack on the joint (10 to 15 minutes) before exercise may decrease stiffness and pain and allow for a more comfortable session. Exercise instructors may also check the room temperature to make sure that the room is not cold. Finally, people who participate in pool exercise program may find it more comfortable in a warmer pool or to wear a T-shirt during the session. The Arthritis Foundation recommends that water exercise take place in a warm water environment between 83-90° F for joint comfort and to promote muscle elasticity.

Swelling can be present in a joint affected by OA. In some people, joint swelling may be increased after exercise and this contributes to an increase in pain. Physiologically, cold therapy, which may be applied with a cold pack, a frozen towel, or ice massage, may decrease pain and swelling, constrict blood vessels and block nerve impulses to the joint. However, the recent systematic review of research has failed to make a definitive conclusion on the effectiveness of cold therapy due to the poor quality of existing

studies.(Brosseau et al., 2008) Nonetheless, there is some evidence that 20 minutes of ice pack may help to decrease swelling of the knee joint compared to no treatment.(Clarke et al., 1974)

Health Education

In addition to exercise and weight loss, health education is a core treatment for individuals with OA. Each training session provides an opportunity to help clients better understand their disease and take the best possible action to maximize mobility and quality of life. Your clients should understand the basic principles of exercise and joint protection, strategies for managing stress and pain, and how to make exercise a daily routine. Direct your clients to the resources listed at the back of this article and in the online course.

CASE STUDY

Your client is a 62-year-old overweight male who has been diagnosed with osteoarthritis of the knee (diagnosed two years, currently managed with NSAIDS) and type 2 diabetes (diagnosed five years ago, controlled with oral medications). He comes to you to help him begin an exercise program for weight loss (he currently weighs 250 pounds and would like to lose 80 pounds). You learn that he is mostly sedentary though he walks occasionally for short distances with his wife after dinner. His primary care physician has advised him to begin a structured exercise program, and he agrees that now is the time to start though he is worried that a strenuous program may cause his knee pain to worsen.

Begin by reassuring your client that you will design an exercise program for him that is least likely to cause him pain and that every effort will be made for him to have a comfortable and enjoyable experience. Ask your client for permission to contact his physician for medical clearance and recommendations prior to beginning the exercise program. Suggest that your client work with a dietitian to begin to make healthier, satisfying, low-fat and lower-calorie food choices to complement the exercise plan and increase the energy deficit. Also discuss fitness testing options with your client.

When designing your client's exercise program, include range-of-motion and stretching exercises, resistance training and cardiovascular conditioning such as a home-based walking program with stretching and weight training. For example, during the first month have the client warm up with easy treadmill walking for five to 10 minutes and perform gentle range-of-motion exercises. Gradually incorporate an additional 10-15 minutes of treadmill walking at 40-50 percent of heart rate reserve, three days per week. After the aerobic/warm-up segment, the client should perform basic strength training exercises for the major muscle groups, with modifications made for the knee as needed. The development of adequate strength to support the knee will allow your client to successfully perform and increase his volume of cardiovascular training. Since the client has knee OA it will be important to improve both quadriceps and hip strength. When doing closed chain exercises such as the leg

press, partial squat or lunge, encourage your client to say “above the pain” during the movement. To minimize joint compression forces at the knee, avoid the leg extension machine, unless you keep your client in the last 30 degrees of terminal leg extension. Hip Abduction and extension exercises may help to promote ideal dynamic alignment at the knee. These may initially be done in a side-lying or seated position. Monitor your client for knee joint pain and, if it increases, reduce treadmill time or try a non-weightbearing exercise mode such as bicycle ergometry or water exercise. Evaluate his joint response to specific strength exercises and modify these exercises as appropriate. This may involve changing body position, decreasing resistance or reducing range of motion. End the training session with targeted stretching exercises.

After the first month has passed, gradually increase the duration of walking/cycling to 30 minutes per session and the frequency to five days per week. Suggest that your client alternate weight-bearing and non-weightbearing forms of cardiovascular exercise to minimize strain on the knees while maintaining energy expenditure. For example, he may perform water exercise 2x/week and walk 3x/week. The intensity of cardiovascular exercise also can be increased to 60 percent of heart rate reserve. Flexibility exercises should conclude each cardiovascular session and strength exercises should be done at least two times per week. These increases combined with careful control of dietary intake can help the client lose about 0.5 to 1 pound per week. This weight loss is critical for the treatment of both the OA and type 2 diabetes.

To ensure long-term success, seek family support of all lifestyle changes. If various goals are met during retesting sessions, organize an incentive system to improve client motivation and interest. During the entire exercise program, close communication with the physician, physical therapist (if applicable), and dietitian (if applicable) is very important.

SUMMARY

OA is the most common joint disease, affecting an overwhelming number of older adults. The potentially disabling disease not only can interfere with establishing and adhering to a regular exercise program but also with one’s quality of life. However, with motivation, education, and guidance from health and fitness professionals, people with OA can enjoy a safe, effective, and motivating exercise program. Although it may not cure OA, regular physical activity decreases pain, improves function, and enhances overall health and quality of life.

RECOMMENDED RESOURCES

American Council on Exercise (ACE) (acefitness.org) – ACE is America's fitness leader in providing certification and continuing education to fitness professionals. ACE offers many courses based on the latest research to help fitness professionals provide design the safest, most effective, and engaging exercise programs possible for individuals from all walks of life.

American College of Rheumatology (ACR) and Association of Rheumatology Health Professionals (ARHP) (rheumatology.org) – The ACR comprises physicians who treat individuals with arthritis while the ARHP is a division of the ACR composed of non-physician health care professionals. In addition to information and resources for professionals, the website also provides patient information and a provider directory.

Arthritis Foundation (AF) (arthritis.org/exercise) – For nearly 60 years, the Arthritis Foundation has been the source for reliable information for the more than 46 million Americans with arthritis. It is the only national, voluntary health organization that works for all people affected by any one of the more than 100 forms of arthritis or related conditions. Chapters nationwide help to support research, professional and community education programs, services for people with arthritis, government advocacy and fundraising activities.

The mission of the Arthritis Foundation is to improve lives through leadership in the prevention, control, and cure of arthritis and related diseases. Public contributions and sales of books (like this one) enable the Arthritis Foundation to fulfill this mission, by helping to fund research, programs, and services. The Arthritis Foundation has more than 150 chapters and branch offices all around the United States that provide support for people living with arthritis, including physician referrals, programs and activities, and useful information that helps people with arthritis lead healthier, more fulfilling lives. Arthritis doesn't have to prevent you from doing the activities you enjoy most. While research holds the key to future cures or preventions for arthritis, equally important is improving the quality of life for people with arthritis today.

Information Hotline-English and Spanish - The Arthritis Foundation—the expert on arthritis—is only a phone call away. Call toll-free at 1-800-568-4045 for automated information on arthritis 24 hours a day. There is a dedicated Spanish speaking staff member to answer your questions in Spanish. Trained volunteers and staff are also available at your local Arthritis Foundation to answer your questions or send you a list of physicians in your area who specialize in arthritis. Also, choose from our more than 60 educational booklets on different types of arthritis, medications, disease management, self-help and more.

Arthritis Help Online - The Arthritis Foundation's interactive website, http://www.arthritis.org, provides a great deal of information and resources that are easy to access 24 hours a day from your home computer.

Through the Arthritis Foundation website, you can chat with other people with arthritis through online message boards, ask questions about your condition and treatment, request free brochures, and purchase books and videos to help you better manage your arthritis. The Arthritis Store contains information about the many books, brochures, and exercise videos published by the Arthritis Foundation. In addition, you can read free material on http://www.arthritis.org, including in-depth feature stories from *Arthritis Today* magazine and news stories about new research, hot trends, and thought-provoking issues related to arthritis prevention and treatment.

Arthritis Foundation Local Chapters - If you have arthritis, your best source of information and support is your local Arthritis Foundation chapter. The staff at your nearest chapter or branch office has many resources to help you live a healthier, more fulfilling life with arthritis. If you are newly diagnosed with a form of arthritis, contact your chapter to find out what they have to offer you. The Arthritis Foundation website can help you find your local Arthritis Foundation chapter easily, and many Arthritis Foundation chapters have their own web pages that will inform you about exercise programs, classes, and other events in your community, as well as exciting opportunities to take part in fundraising events, walks, and marathons. Most Arthritis Foundation chapters can give you a list of doctors in your area who specialize in the evaluation and treatment of arthritis and arthritis-related diseases.

Exercise Programs and Other Classes - Many people who become involved in one type of physical activity and find that they like it go on to explore other kinds of programs that also are enjoyable and offer health benefits. No matter what your ability, the Arthritis Foundation can help you keep moving. The Arthritis Foundation offers both land- and water-based programs that benefit beginners as well as exercise veterans. Contact your local chapter to find out where and when these programs will be held.

- The ***Arthritis Foundation Exercise Program*** is an eight-week instructor led program. It uses gentle activities to help increase joint flexibility and range of motion and help maintain muscle strength. Exercises are done while sitting, standing, or on the floor. Participants previously enrolled in the program have experienced such benefits as increased functional ability, increased self-care behaviors, decreased pain, and decreased depression.
- The ***Arthritis Foundation Aquatics Program*** is a safe, ideal environment for relieving arthritis pain and stiffness. The program is offered at three levels: The Basic Program, The Plus Program, and The Deep-Water Program. These programs can be offered either in sessions of up to 12 weeks in length or ongoing, depending on the facility where the program is offered. The Deep Water Program is for people who have

progressed beyond the fitness level accommodated for the basic and plus classes. The gentle activities in warm water, with guidance from a trained instructor, will help you gain strength and flexibility. Participants previously enrolled also enjoyed benefits such as decreased pain and stiffness.

- ***Tai Chi from the Arthritis Foundation®*** is designed to improve the quality of life for people with arthritis, using Sun-style Tai Chi, one of the four major recognized styles. This style includes agile steps and exercises that may improve mobility, breathing, and relaxation. The movements don't require deep bending or squatting, which makes it easier and more comfortable to learn. The program itself consists of 12 movements — 6 basic and 6 advanced— a warm-up and a cool-down. Once participants become familiar with the 12 movements, the program is designed to provide continual challenge by reversing the direction of the movements.

The Arthritis Foundation Self Help Program – This is a self-management program. This program helps you learn the skills you need to build your own self-management program that helps you to become an active member of your health care team, work better with your health care providers and handle the day-to-day challenges of your disease. The program includes six weeks of group education designed to complement the care provided by your health care team and allow you to share experiences with others. Past participants of the Self Help Program have experienced such benefits as increased knowledge about their arthritis, increased frequency of exercise and relaxation; increased self-confidence, decreased depression and pain, and fewer physician visits.

Publications and Videos/DVDs - Arthritis Foundation publications are available by calling 1-800-283-7800, or by logging on to http://www.arthritis.org and selecting the Arthritis Store tab.

- ***Brochures***. The Arthritis Foundation chapter nearest you will have an array of free educational brochures on a wide variety of arthritis-related topics, from specific diseases, lifestyle challenges, current medications and more. All brochures are concise and easy to understand and point you to other resources for managing your arthritis.
- ***Arthritis Today***. This award-winning magazine brings you up-to-date, reliable information about the latest research and treatment options, diet and nutrition, tips for traveling and making your life with arthritis easier and more rewarding. Subscribe to six issues a year, and find all the information you need to achieve a healthier, more active life with arthritis.
- ***Books***. In addition to *Walk With Ease*, the Arthritis Foundation publishes a number of books for people with arthritis and for others seeking to create a healthier lifestyle. All Arthritis Foundation books have been given a thorough medical review by leading physicians and health care professionals, so you can be sure that you are receiving sound

information about your health, fitness, and arthritis management. Arthritis Foundation books are available through the website and number given above, and they are also sold in bookstores nationwide.

- *The Arthritis Foundation's Guide to Managing Your Arthritis.* (#835-245) This comprehensive, yet clear and easy-to-read book offers basic information about managing your arthritis. The book discusses the many types of arthritis, how your doctor will diagnose your condition, common drugs, surgical and alternative therapies for arthritis, and how you can treat symptoms and create an active, fulfilling life with arthritis. $16.95
- *Good Living With Osteoarthritis (*#835-221)
- *Good Living With Rheumatoid Arthritis* (#835-222)
- *Good Living With Fibromyalgia* (#835-228)
- Get specific information about taking control of your condition in one of this series of books. Each book offers information on diagnosis, causes, drugs, surgical techniques, self-management strategies and alternative therapies. You'll find a handy guide to prescription and over-the-counter drugs for the particular disease, and easy exercises you can do to improve mobility and reduce pain. $16.95 each
- *Tips for Good Living with Arthritis.* (#835-230) You'll find more than 700 tips for making your daily activities easier and less painful in this handy guidebook. The book offers basic information about the most common types of arthritis, and what you can do to protect your joints as you go about your day. $9.95
- *Toward Healthy Living: A Wellness Journal*. (#835-205) Today's health experts recommend keeping a journal to express your feelings and monitor your arthritis or related condition. This beautifully designed, spiral-bound journal not only gives you space to collect your thoughts, but it contains areas to monitor you mood and pain levels. Plus, you'll discover words of wisdom shared by a variety of famous and "everyday" people who live with chronic illness. Take care of your mind as well as your body. *$9.95*
- *Celebrate Life: New Attitudes for Living With Chronic Illness*. (#835-219) Nurse, counselor, mother—and a woman with arthritis. Author Kathleen Lewis, RN, offers practical experience and guidelines for creating a fulfilling life with a chronic illness. Lewis explores diagnosis and medical treatment, dealing with family and friends, sexuality and finding the inner strength to celebrate your life despite your arthritis. $6.95
- *Beyond Chaos: One Man's Journey Alongside his Chronically Ill Wife*. (#835-214) Author and consultant Gregg Piburn offers a candid, revealing and inspiring look at being a spouse of a person

with a chronic illness. Piburn examines his role as his wife, Sherrie, dealt with fibromyalgia, including the struggle to find a diagnosis and the dramatic shifts in their relationship. $7.95

- **DVDs**
    - *Take Control With Exercise*. (#835.9035) This upbeat 60-minute fitness DVD provides a balanced exercise routine based on the Arthritis Foundation Exercise Program, a proven method for getting in better shape no matter what shape you're in now and created specifically for people with arthritis. The DVD includes two optional endurance routines to create a more challenging workout and a relaxing guided imagery segment to help you manage stress. $19.95
    - *Arthritis Water Exercise*. (#835.9025) This exercise DVD is based on the popular Arthritis Foundation Aquatic Exercise Program. $29.95
    - *Tai Chi for Arthritis DVD* is a collaboration between the Arthritis Foundation and Dr. Paul Lam and is based on the Arthritis Foundation Tai Chi Program. This informative DVD collection introduces Tai Chi and includes basic, intermediate and advanced warm ups suitable for all levels. People can achieve stress reduction and improve balance and flexibility by using these evidence-based exercise routines. The Tai Chi DVD series also shows how to manage pain and promote healing.
        - Tai Chi for Arthritis DVD Series:
            - **Tai Chi for Arthritis DVD - Part I**
                - **6 Core Movements in 6 Lessons**
            - **Tai Chi for Arthritis DVD- Part II**
                - **6 Extension Movements in 6 Lessons**
            - **Tai Chi for Arthritis DVD Combo**

            The complete program in 12 Lesson on a 2 disk set

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) (niams.nih.gov/) – NIAMS, a branch of the National Institutes of Health (NIH) provides information about OA and various other rheumatic, bone, muscle, and joint diseases. It also distributes patient and professional education materials.

American Academy of Orthopaedic Surgeons (AAOS) (aaos.org) – The professional organization of Orthopedic Surgeons, the AAOS provides information on OA, a provider directory, and the latest breaking news and research on various orthopedic disorders.

Medline Plus: Osteoarthritis (nlm.nih.gov/medlineplus/osteoarthritis.html) – Medline Plus provides an overview of OA as well as links to numerous online resources including an interactive tutorial. The website provides links to learn

more about the basics, the latest research, newsletters and print publications, statistics, and more.

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